TARGETS DEVELOPMENT OF LOW ENRICHMENT FOR PRODUCTION OF Mo^{99} FOR FISION

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1-ABSTRACT

The purpose of this work is the replacement of the current targets of High Enrichment Uranium (HEU-90% p. 235U) by a uranium compound of low enrichment (LEU-20% p. 235U) for production of fission Mo^{99}, using a dispersed uranium Aluminum phase.
This work describes the manufacturing of UAl2 compound and the powder metallurgical compact process with an approximate density of 3 gU/cm3 in the targets.
With this load of uranium reached in the targets, Uranium Aluminum can be replaced the current miniplate of High Enrichment Uranium (HEU), without any geometric modifications and maintaining the current process of basic dissolution in the radiochemical process.

The Uranium Aluminide compound was selected due to its very convenient characteristic, specially in density it is 6,42 g/cm^3.

2 – INTRODUCTION

As Argentine is an active participates in the RERTR Program since 1978 and is one of the manufacturing countries is needed to reduce the use of HEU for the production of Mo99.

One of the main achievements was the conversion of the RA-3 core in CNEA Argentina during 1990.

3 - DESCRIPTION

The use of LEU in the targets makes necessary increase in the 235U load in order to obtain the same production of 99Mo. This increment is approximately 20% in weight.

The target for the production 99Mo consists in fuel meat of Uranium Aluminum dispersed in the aluminum matrix. The cladding is an aluminum alloy 6061(Al-Mg-Si) it has no problem in the basic dissolution process (1).

The dimension of the targets it is shown above (2).

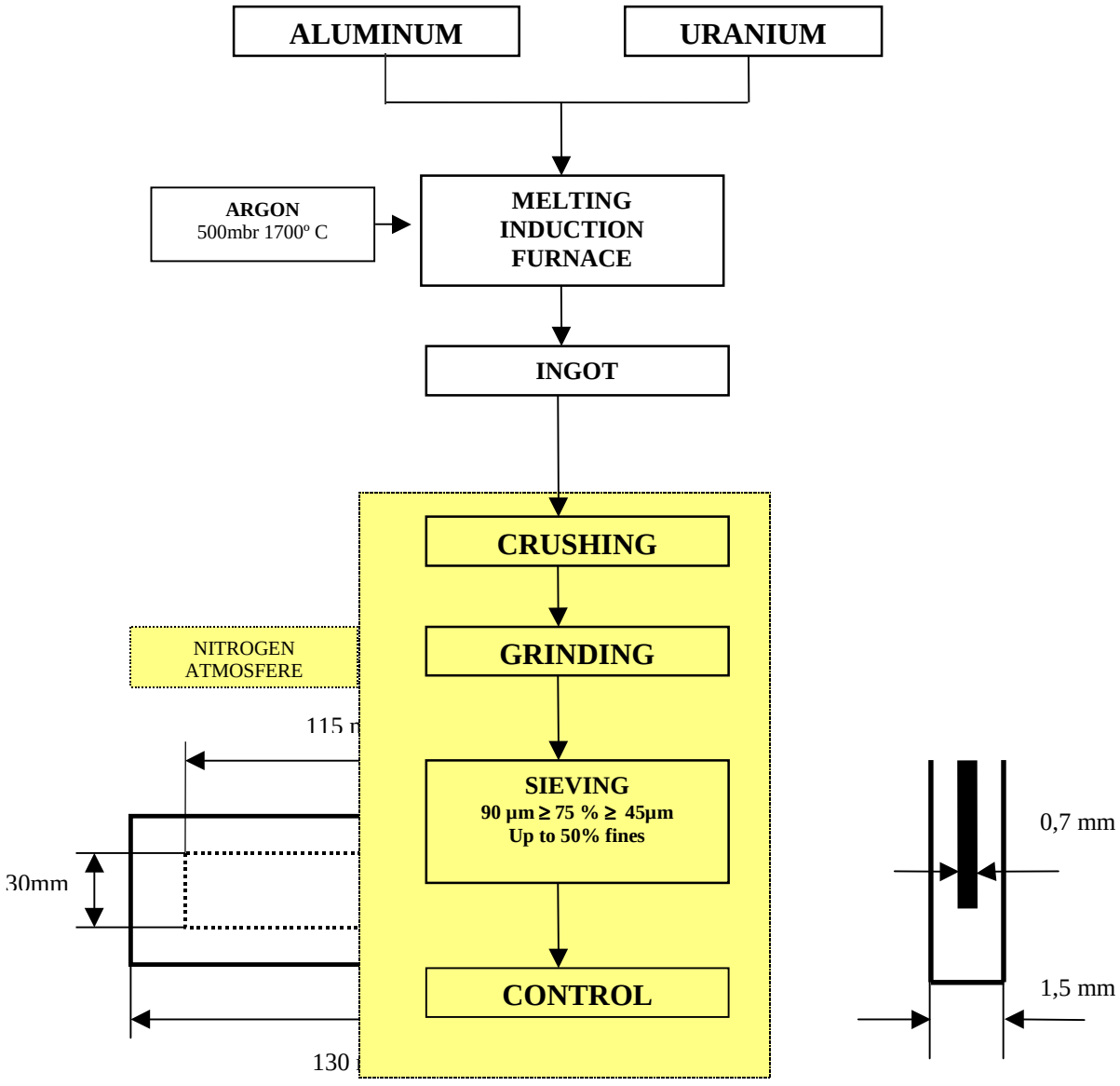
4 – MANUFACTUING PROCESS

The manufacturing process is the same used for Low Enrichments Uranium fuel plates (3,4,5,6). The miniplates are fabricated by melting Uranium and Aluminum and powder metallurgy process like crushing, grinding and sieving.

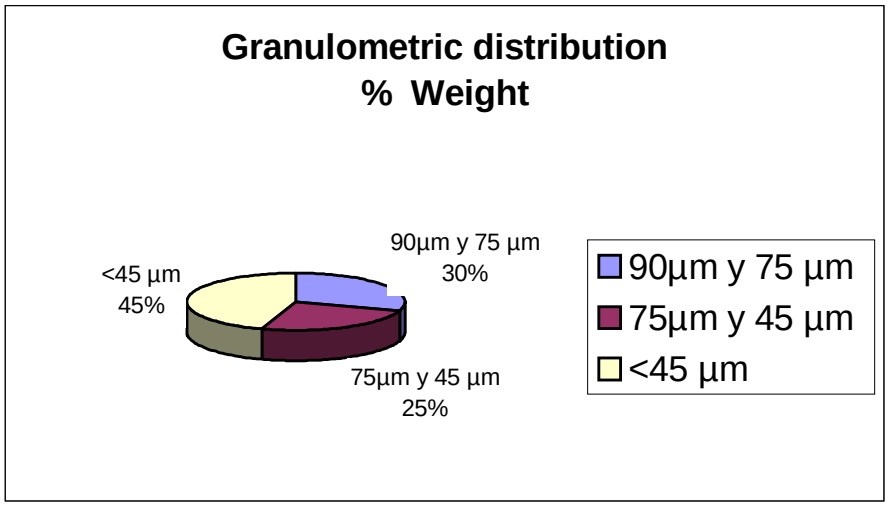
The compound is prepared in an induction furnace, starting with metallic Uranium and atomized powder Aluminum, using alumina crucible (7) in an argon atmosphere. The melting temperature is approximately 1620 ºC.

The ingot obtained is crushed in a jaw crusher, grinded by satellite ball milling and then sieved in a nitrogen atmosphere in a glove box, taking care of the oxygen content, it has to be less than 4% vol. The granulometric distribution of the powder obtained is 75% between 44 and 90 microns tolerating up to 50% of fine.

A flow sheet is shown above.



Both powders are blended; the loading is not more than 50% in volume of dispersed phase.



The compact is prepared by cold pressing, the pressure of compaction was 450 Mpa.

The compact is processed by the conventional picture in frame technique The cladding material is Aluminum alloy 6061.

The hot rolling temperature was 485 ºC with seven passes an obtaining 80 % of reduction. After the cold rolling the total reduction was 82%.

After hot and cold rolling we obtained 82 % of thickness reduction.

The annealing process produces the transformation of UAl_2 in UAl_3 and UAl_4. These two compounds show good basic dissolution behavior during the subsequent radiochemical processing.

A flow sheet of this process is shown above.

5- RESULTS

The granulometric distribution obtained in the powder is shown in the diagram.

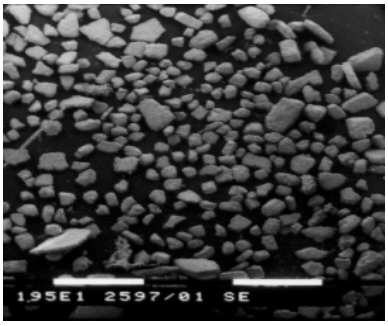
In the picture we showed SEM image of the powder.

In the X-ray diffraction we can see the characteristics peaks of UAl_2, UAl_3 and UO_2.

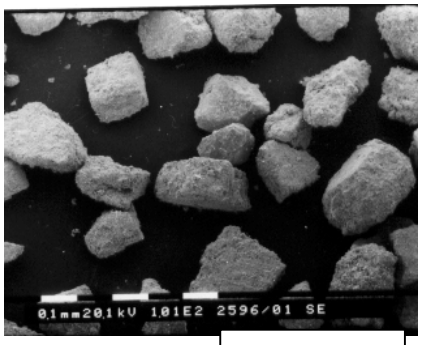
Other controls in the Aluminum Uranium powder were pycnometric density, specific area, chemical composition (potentiometer tritation) and microhardness.

Ten miniplates were manufactured in the following table we can see the most important characteristics.

Plates N°	Weight [g]		Compound UAl2			U total [g]	U (235) [g]	Density GUt/cm3
	Plate	Nucleus	[g]	% P.	% Vol.			
MAE 001	22,28	11,60	8,66	74,7	49,3	7,08	1,40	2,95
MAE 002	22,34	11,83	8,67	73,3	47,5	7,08	1,40	2,85
MAE 003	22,30	11,83	8,67	73,3	47,5	7,08	1,40	2,85
MAE 004	22,30	11,83	8,67	73,3	47,5	7,08	1,40	2,85
MAE 005	22,29	11,84	8,68	73,3	47,5	7,09	1,40	2,85
MAE 006	22,34	11,81	8,65	73,3	47,5	7,07	1,40	2,87
MAE 007	22,32	11,82	8,66	73,3	47,5	7,08	1,40	2,88
MAE 008	22,34	11,85	8,68	73,3	47,5	7,10	1,40	2,88

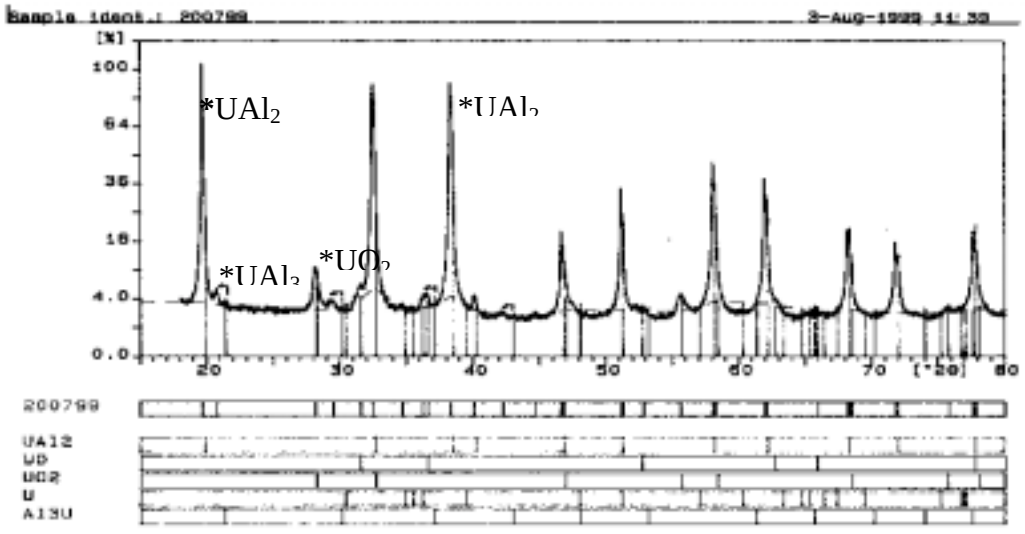


20x



100x

MAE 009	22,37	11,87	8,70	73,3	47,5	7,11	1,41	2,86
MAE 010	22,32	11,83	8,67	73,3	47,5	7,08	1,40	2,86
Enrichment: 19,78 % p. U235								



The following controls were carried out with satisfactory results.

- Blister test
- Radiographic control for cutting.
- Homogeneity by X-rays radiography.
- Dimensional control.
- Visual inspection.
- Destructive exam for clad thickness

6 – CONCLUSIONS

- It has been demonstrated that it is possible to replace the HEU targets with LEU targets using UAl_2, without modifying the geometry.
- The target irradiation LEU was carried out in the reactor RA-3, with a similar irradiation program like the current target HEU. Once concluded the irradiation, the targets were processed in the facilities of the group" 99Mo of fission". CAE- CNEA (8). The targets show good dissolution behavior towards basic and acid dissolution.
- The targets had good irradiation behavior and satisfactory post irradiation processing.
- The LEU miniplates cost is similar to the HEU ones.

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Mo99 Production Division

7 - REFERENCES

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